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January 20, 2000

Mr. William Grimley
Environmental Protection Agency
Emission Measurement Center (MD-19)
Research Triangle Park, NC 27711

Subject: **Test Report, "Ontario-Hydro" Mercury Program, Stockton CoGen Plant, Stockton, California (99057)**

Dear Mr. Grimley:

Three copies (two bound and one unbound) of the Test Report for the "Ontario-Hydro" mercury tests conducted at the Stockton CoGen Plant are enclosed for your review. The report has been prepared and written according to the EPA guideline document, "Preparation and Review of Emission Test Reports" dated December 1998. At the request of Mr. Tom Hess of the Stockton CoGen Company, I have forwarded the report straight to you. The tests were completed on October 22, 1999.

Please call me at (925) 680-0935 if you have any questions or comments. Thank you for your patience and expedient review.

Sincerely,

Erick Mirabella

Erick M. Mirabella
Project Manager

Enclosures (3)

L99057

SOURCE TEST REPORT
1999 MERCURY SPECIATION STUDY
STOCKTON COGEN COMPANY
STOCKTON, CALIFORNIA

Prepared For:

STOCKTON COGEN COMPANY
7201 Hamilton Blvd.
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For Submittal To:

Mr. William Grimley
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JANUARY 2000

REVIEW AND CERTIFICATION

All work, calculations, and other activities and tasks performed and documented in this report were carried out under my direction and supervision.

Name: Erick Mirabella   Title: Project Manager

Sign: Erick Mirabella   Date: 1/20/00

I have reviewed, technically and editorially, details, calculations, results, conclusions, and other appropriate written material contained herein, and hereby certify that the presented material is authentic and accurate.

Name: Kevin J. Crosby   Title: QA Manager

Sign: Kevin J. Crosby   Date: January 20, 2000

SUMMARY INFORMATION

Source Information

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Title:	Lead Environmental Engineer
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Unit:	Coal / Petroleum coke / TDF-fired CFBC boiler
Purpose:	Mercury Speciation Study
Procedures:	April 8, 1999 - "Ontario Hydro" Method
EPA Permit to Operate:	N/A
District Permit to Operate:	N/A

Testing Company Information

Testing Firm:	The Avogadro Group 4085 Nelson Avenue, Suite E Concord, CA 94520	
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Certification:	ARB Independent Tester	
Test Dates:	October 20-22, 1999	

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SECTION 1.0

INTRODUCTION

1.1 TEST PROGRAM SUMMARY

The U.S. Environmental Protection Agency (EPA), Office of Air Quality Planning and Standards (OAQPS), Emission Inventory Branch (EIB) is responsible for developing and maintaining air pollution emission factors for industrial processes. The EPA used its authority under section 114 of the Clean Air Act, as amended, (the Act) to require that selected coal-fired electric utility steam generating units provide certain information that will allow the Agency to calculate the annual mercury emissions from each such unit. Stage III of the project involves collecting speciated mercury emissions data from these statistically selected sources.

EPA, in its letter of 11 March 1999, notified Stockton CoGen Company that its facility in Stockton, California had been selected to perform the emissions testing at the inlet and outlet of the last emission control device (baghouse). The purpose of this study is to provide data for use in health and environmental impact assessments and optimizing and evaluating the mercury removal efficiency of the present emission control technologies.

The Avogadro Group (AVOGADRO) located in Concord, California, was contracted by Stockton CoGen Company to perform the emission tests at their facility in Stockton, California. AVOGADRO conducted the testing as required by the EPA. Erick Mirabella, Kevin Crosby, Dan Duncan, John Pascale, and Peter Gates of AVOGADRO performed the tests on October 20 through 22, 1999. Tom Hess of Air Products and Chemicals, Inc. coordinated the plant operations. The tests were conducted according to a site-specific test protocol that was submitted to and approved by the EPA on September 30, 1999. EPA personnel made no direct observations of the tests.

Triplicate test runs were conducted on the circulating fluidized-bed combustor (CFBC) unit at both the inlet to the baghouse and the boiler stack (outlet) for simultaneous measurement of speciated mercury emissions using the "Ontario Hydro" Mercury Method. Boiler operating data (i.e. steam production, gross MW, and fuel firing rates) were recorded during each test run. Ammonia injection (SNCR NO_X control) and limestone injection (SO_2 control) rates were also monitored. Coal samples best approximating the fuel fired to the boiler during each test run were taken and analyzed for heating value, sulfur, ash, chlorine, and mercury.

The emission test results are presented in Section 3.0. All supporting data are located in the appendices.

1.2 TESTING CONTRACTOR

The Avogadro Group (AVOGADRO) is a consulting and testing firm specializing in combustion and combustion-generated air pollution emissions, emission control, emission measurement, continuous emission monitoring systems and regulatory affairs. The organization possesses technical expertise for a variety of stationary combustion device types, including utility and industrial boilers, municipal solid waste and other refuse-fueled boilers, fluidized-bed boilers, simple-cycle, combined-cycle, and cogeneration gas turbines, and a variety of specialized process equipment.

Source test personnel have completed courses offered by the California Air Resources Board and U.S. Environmental Protection Agency and are thus well trained with regard to accepted emissions measurement methodology and protocol. Personnel continually update their knowledge and expertise by attending instruction courses and seminars offered by CARB and the EPA Air Pollution Training Institute.

Pursuant to California Air Resources Board Executive Order G-94-028, AVOGADRO is currently certified as an independent test agency with respect to the following CARB Methods 1, 2, 3, 4, 5, 6, 8, 10, 17, 100, and 202. Our CARB certification is included in Appendix C. AVOGADRO also performs sampling and testing for a wide variety of substances such as air toxic contaminants in addition to those substances covered by the Methods for which it holds certification.

1.3 TEST PROGRAM KEY PERSONNEL

The test program was conducted by The Avogadro Group. The contact persons for the project were:

• The Avogadro Group:	Erick Mirabella	(925) 680-0935
• Stockton CoGen Company:	Tom Hess	(610) 481-7620
• Stockton Plant	Todd Shirley	(209) 983-0391 x112
• Environmental Protection Agency	William Grimley	(919) 541-1065

AVOGADRO provided a professional source test team to conduct the testing as described in this report. The test team members assigned to this project were familiar with the testing of fluidized-bed boilers and have successfully conducted source tests at the Stockton Cogen facility over the last seven years. The personnel chosen for the team were based on specific experience and proficiency with the methods used.

Mr. Erick Mirabella was team leader for the air sampling activities at Stockton Cogen. As project manager, Mr. Mirabella's responsibilities included overseeing the execution and planning of all air sampling efforts including testing, reporting and project coordination. Mr. Mirabella's primary objective was to ensure that the results generated by this test program meet the expectations and requirements of both the EPA and Stockton CoGen Company. Mr. Mirabella regularly oversees the annual compliance testing at this facility and has conducted numerous air toxic emission tests at this and other facilities in California and around the United States.

Mr. Mirabella appointed Mr. Dan Duncan as the project chemist. Mr. Duncan's responsibilities included laboratory and sample glassware preparation, sample train recovery and sample custody. He ensured that the proper paperwork and samples reached the laboratory and were analyzed according to the test protocol, and that both the field and laboratory efforts were in compliance with the EPA approved procedures.

Mr. Kevin Crosby was the Quality Assurance Officer for the project. He reviewed and validated all of the lab analyses and test results. A summary of our standard QA/QC program is presented in Section 5.0 and Appendix B.

Mr. John Pascale and Mr. Peter Gates were responsible for the sampling activities. Mr. Pascale conducted the mercury tests at the inlet to the baghouse, while Mr. Gates performed the tests at the stack outlet.

Figure 1-1 presents a test program organizational chart with the major lines of communication and the names and phone numbers of responsible individuals and key personnel.

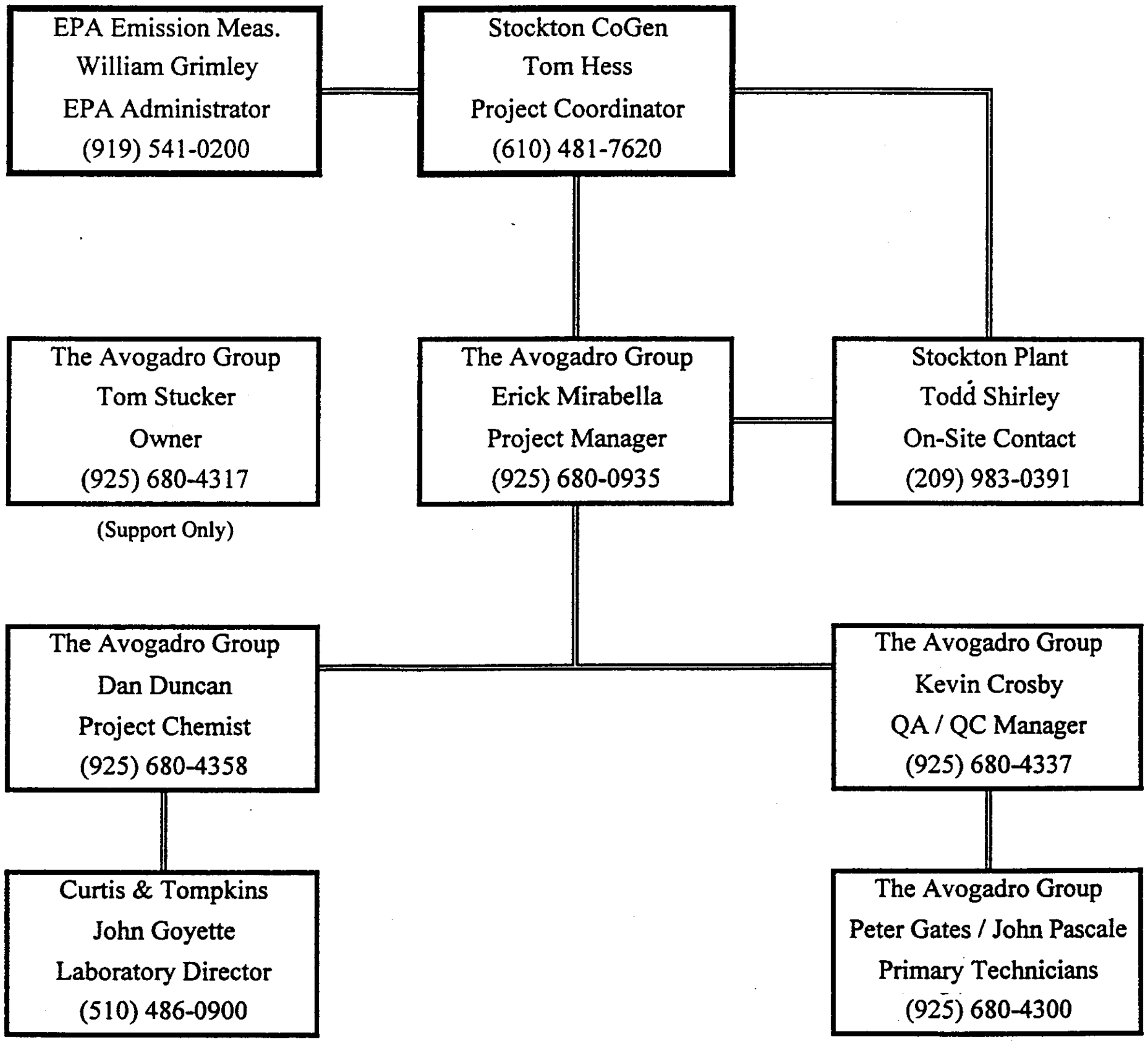

Figure 1-1 Test Program Organizational Chart

SECTION 2.0

FACILITY DESCRIPTION

Stockton CoGen Company (SCC) operates a cogeneration facility on Zephyr Street in Stockton, California. This facility produces both electrical power and steam. Most of the steam is produced by a boiler that includes a circulating fluidized bed combustor (CFBC). The fuel usually burned in the combustor is a combination of bituminous coal, petroleum coke (fluid and delayed), and tire-derived fuel (TDF). Most of the steam generated by the boiler is used to provide electric power, primarily for sale to the local utility company, but some power is also sold to International, the facility adjacent to SCC. Process steam is also sold to the CPC corn processing plant. Figure 2-1 presents a detailed plant process flow diagram.

During the tests, the facility was operating at nominal, steady state, full-load conditions, firing coal and fluid coke. The process conditions for the facility during the test program are documented in Table 2-1.

**TABLE 2-1
PROCESS CONDITIONS
STOCKTON COGEN COMPANY
MERCURY SPECIATION TESTS
OCTOBER 20-22, 1999**

Test No.	Bituminous Coal Feed, lb/hr	Fluid Coke Feed, lb/hr	Limestone Feed, lb/hr	CFBC Unit Load MW	Steam Production lb/hr
1-Hg	37,479	17,824	5,265	59.8	524,028
2-Hg	30,305	24,359	8,413	59.7	514,759
3-Hg	33,048	23,063	8,778	60.0	525,437

A natural gas-fired auxiliary boiler provides additional steam generation when necessary. The boiler has a firing capacity of approximately 150 MMBtu/hr. Fuel for the boiler is pipeline quality natural gas. Emissions are controlled using a low-NO_X burner and a flue gas recirculation (FGR) system. The auxiliary boiler was not tested during this emission testing program.

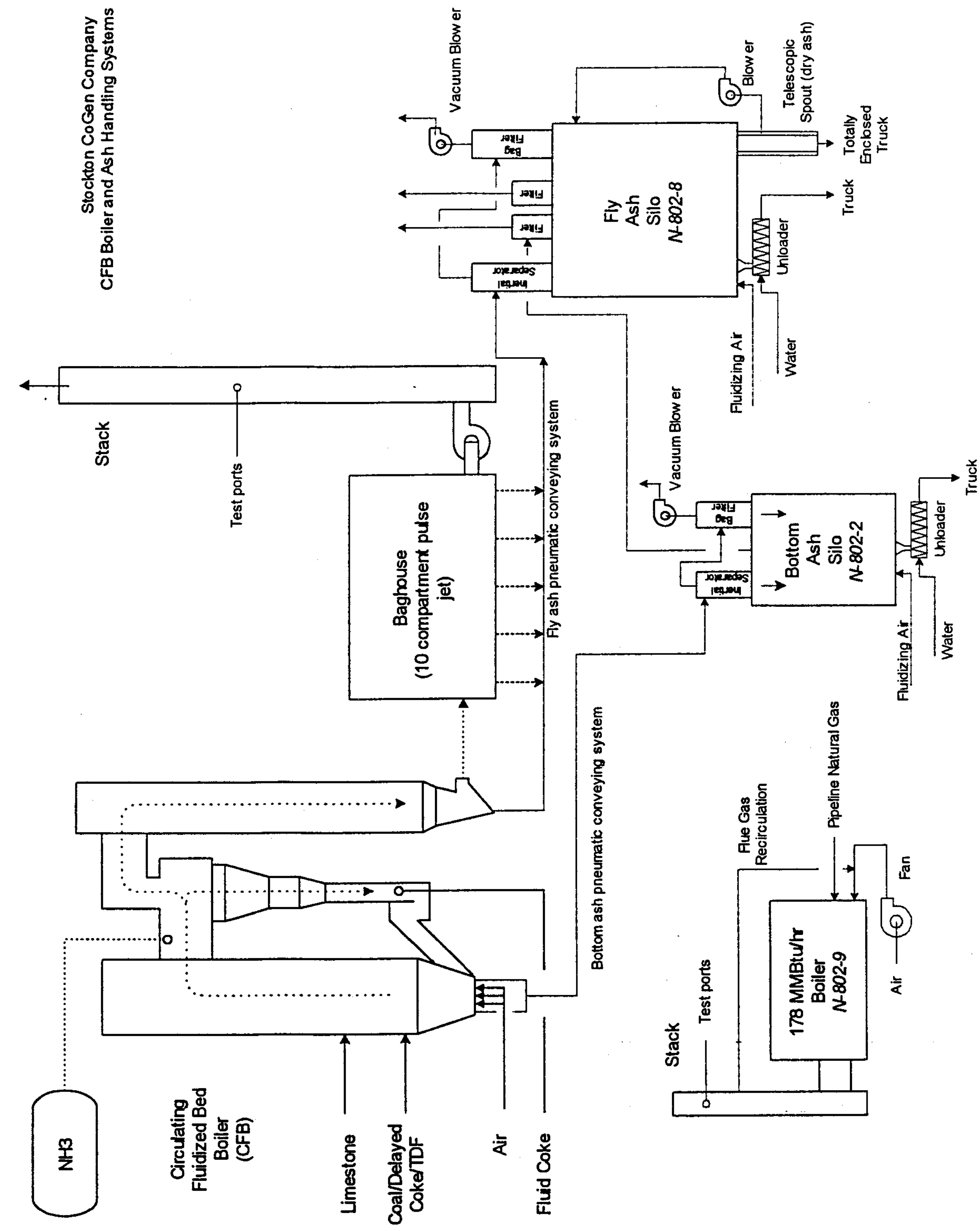

Figure 2-1 Plant Process Flow Diagram

2.1 PROCESS DESCRIPTION

2.1.1 Circulating Fluidized Bed Combustor

During normal process conditions, the circulating fluidized-bed combustor (CFBC) simultaneously fires a mixture of fuels (approximately 55,000 lb/hr) including low sulfur (0.5%) western bituminous coal, petroleum coke (both delayed and fluid), and tire-derived fuel (TDF) at a normal firing rate of 620 MMBtu/hr. For the Mercury emission testing program, only coal and fluid coke were fired in the CFBC.

In the CFBC boiler, primary air enters the bottom of the boiler where it fluidizes a mixture of crushed fuel and pulverized limestone. Combustion gases and entrained particles leaving the combustion chamber enter two parallel cyclones where the bulk of the suspended solids are removed and recycled back to the combustion chamber.

Coke and limestone are fed together into the boiler at six points - four at the front wall of the boiler and one in each of the cyclone return legs (fluid coke is fed here). Combustion gases pass from the cyclones through the convection zone and enter a baghouse before being exhausted to the atmosphere. From the baghouse, flue gas passes through an induced draft fan and is discharged to a 150-foot stack. Below are some typical operating parameters for the CFBC and the facility:

Generator	60 MW
To utility	50 MW
To corn milling plant	5 MW
Plant auxiliary	5 MW
Boiler	620 MMBtu/hr (nominal)
Total steam	510,000 lb/hr
Export steam	110,000 lb/hr
Fuel firing rates	
Bituminous coal	28,000 lb/hr (12,000 Btu/lb)
Fluid petroleum coke	20,000 lb/hr (15,000 Btu/lb)
Delayed petroleum coke	3,000 lb/hr (13,000 Btu/lb)
Tire derived fuel ("TDF")	3,000 lb/hr (15,000 Btu/lb)

2.1.2 Fuel Handling System

Figure 2-2 shows the fuel handling system when all of the fuels are normally used. Coal is primarily received by rail, but truck delivery is possible. Petroleum coke and TDF are delivered only by truck. Bottom dump rail cars and trucks (coal/delayed coke) unload in the unloading building from which coal and delayed coke are conveyed into either of two storage silos. Fluid coke is pneumatically conveyed from delivery trucks into a single fluidized coke storage silo. TDF and some delayed coke are delivered in walking bed trailers that discharge to three unloading hoppers.

With the exception of fluid coke, all fuels are conveyed to two plant silos that feed the boiler through gravimetric feeders at six feed points. Fluid coke is fed pneumatically to the loop seals of the boiler.

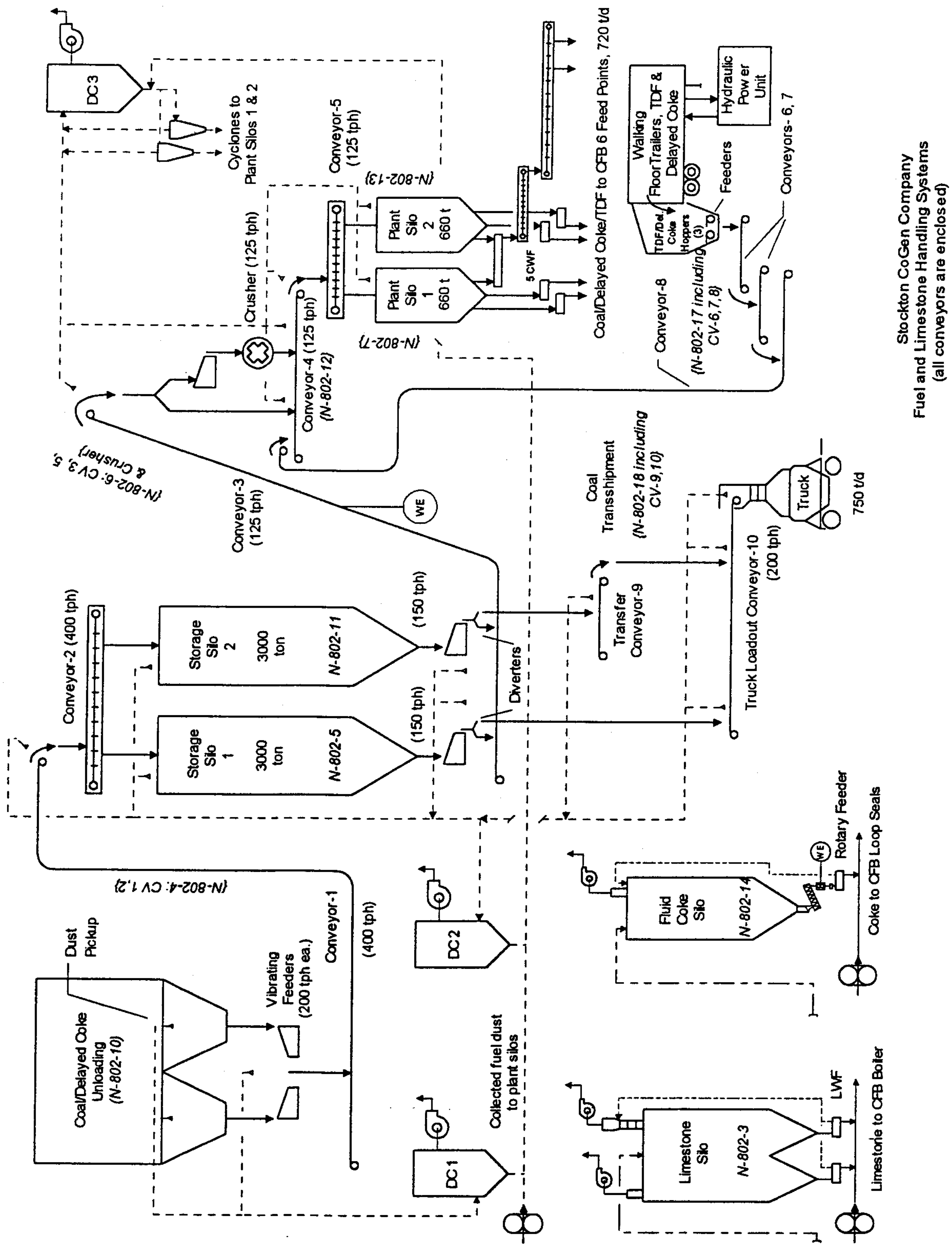

Figure 2-2 Schematic of the Fuel Handling System

2.2 EMISSION CONTROL EQUIPMENT

The boiler is equipped with the following pollution control systems:

1. **Ammonia injection system** - Approximately 50 to 160 lb/hr of anhydrous ammonia is injected at the inlet of the cyclones upstream of the boiler convective section to control NO_X through selective non-catalytic reduction of NO_X to N_2 and H_2O. Feedback control for SO_2 and NO_X emission control systems is provided by the continuous emission monitoring system located at the stack[1].

2. **Limestone injection system** - This system adds approximately 2,000 to 7,000 lb/hr of limestone (at nominal load) to the bed material of the boiler for control of SO_2 emissions. Direct limestone injection captures SO_2 in the combustor by forming $CaSO_4$, which is removed as part of the fly ash by the baghouse.

3. **Baghouse** - This system controls particulate emissions.

Two sootblowing systems are installed to ensure the cleanliness of the convective section of the boiler. Acoustic sootblowers are installed in the upper part of the boiler's convective section. A low-frequency acoustic signal is used to prevent the buildup of fouling material on the boiler tubes. These acoustic sootblowers operate continuously during boiler operation. In addition, conventional steam sootblowers are also installed on the boiler. These steam sootblowers are normally operated for 30 minutes during each operating day, with a maximum steam rate of approximately 15,000 lbs. steam/hr. Figure 2-3 presents the emission control system diagram.

Limestone rate:	6,300 lb/hr
Ammonia injection rate:	160 lb/hr
Baghouse:	Pulse jet
No. of compartments	10
Bags/compartment	252
Total cloth area	56,200 square feet
Bag material	Fiberglass with 10% Teflon B
Baghouse inlet pressure	-12 iwc
Baghouse inlet temperature	320 °F

[1] In-situ Monitor Labs SO_2/NOx analyzer, in-situ CO_2 (diluent) analyzer, opacity monitor, and EMRC (pitot) stack flow monitor.

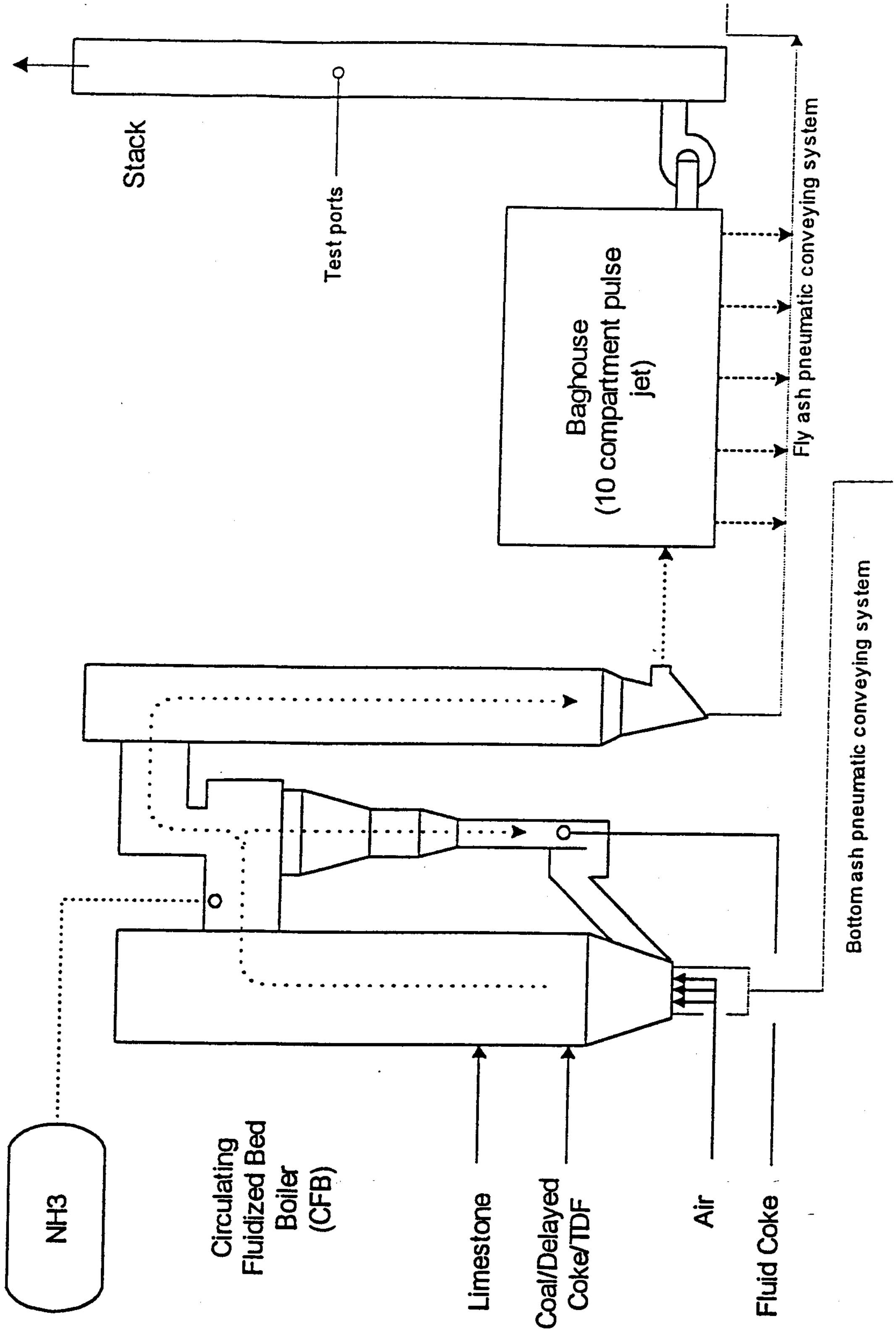

Figure 2-3 Emission Control System Diagram

2.3 EMISSION MEASUREMENT LOCATIONS

Mercury samples were collected concurrently at the inlet to the baghouse and the outlet of the baghouse (boiler stack) during the testing program. These locations are described in more detail in the sections below:

2.3.1 Baghouse Outlet

Stack gas samples were collected from sampling ports located on the stack at the sampling platform. Four sampling ports (4-inch diameter and 12 inches long from the stack wall), each 90° apart from one another, are installed approximately 54 feet (6.8 diameters) downstream from the nearest flow disturbance and greater than 16 feet (2 diameters) from the stack exit. This sampling location meets EPA Method 1 criteria. The stack has an inside diameter of 8 feet. A 16-point traverse of the stack was conducted during each isokinetic test, using traverse points located according to EPA Method 1. Sampling was conducted for 10 minutes per point, resulting in 160-minute test runs. A schematic of the outlet sampling location is shown in Figure 2-4.

2.3.2 Baghouse Inlet

The baghouse inlet duct carries boiler exhaust gases from the final boiler section and air preheater section of the process into the baghouse for removal of particulate matter. The duct is rectangular in cross-section, but the sides are not parallel. The duct is oriented approximately 25 degrees downward from horizontal, and includes a set of turning vanes and an "egg crate" type of flow straightener. The duct then makes a turn to a nearly horizontal section just before entry into the baghouse. At this point, the sides of the duct are parallel, and the bottom surface is horizontal. The sampling ports are located across the top surface, which is angled slightly downward from horizontal (roughly 5 degrees). A schematic of the inlet sampling location is shown in Figure 2-5.

There are four 4-inch diameter sampling ports (three 12-inch long ports with nipples and one 12-inch long flange-type port) each located on the centroid of equal cross-sectional areas. This sampling location does not meet EPA Method 1 criteria as the ports are located approximately 3 feet downstream from the nearest flow disturbance and 3 feet upstream from the baghouse entrance. The duct at this location has cross-sectional

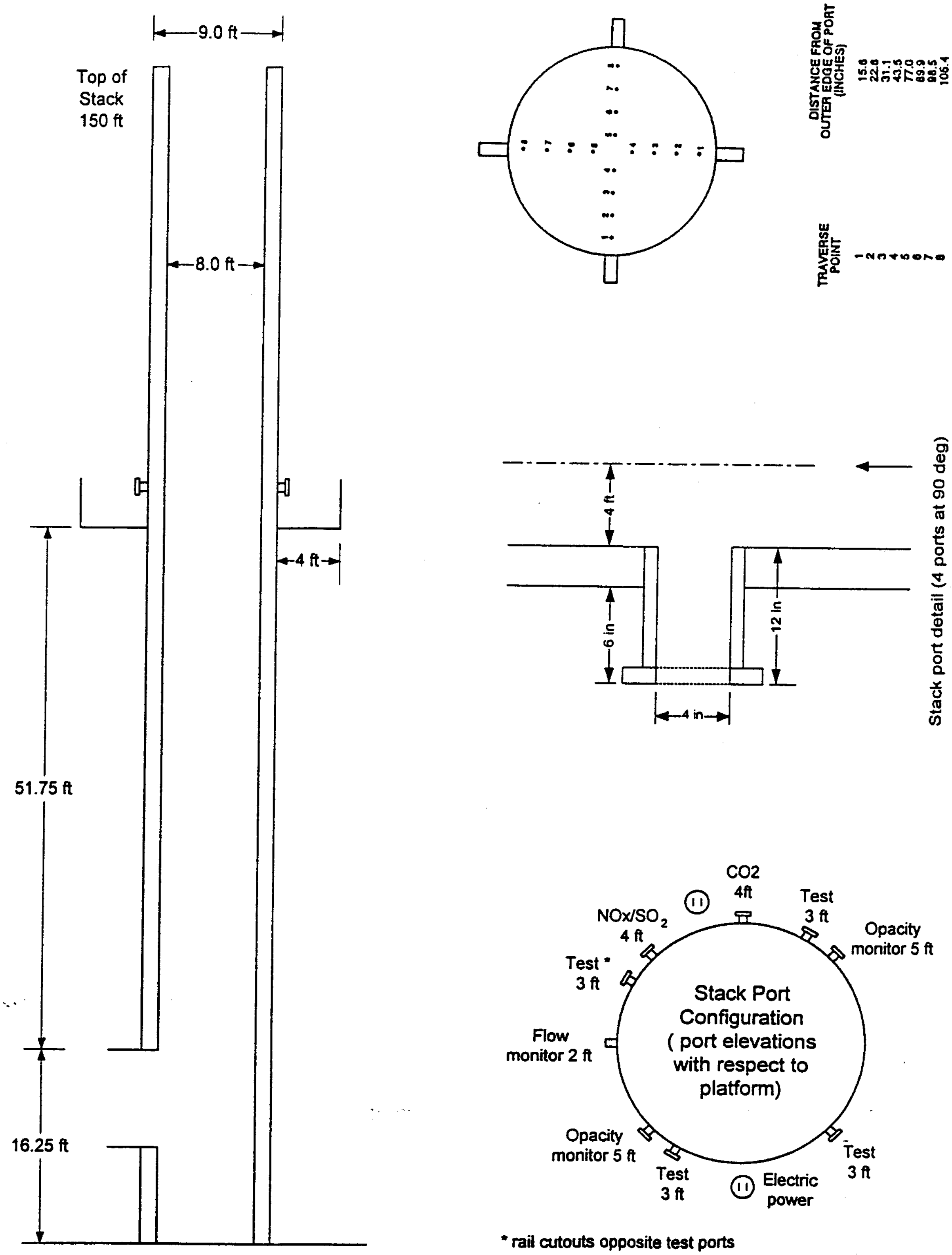

Figure 2-4 Schematic of the Outlet Sampling Location

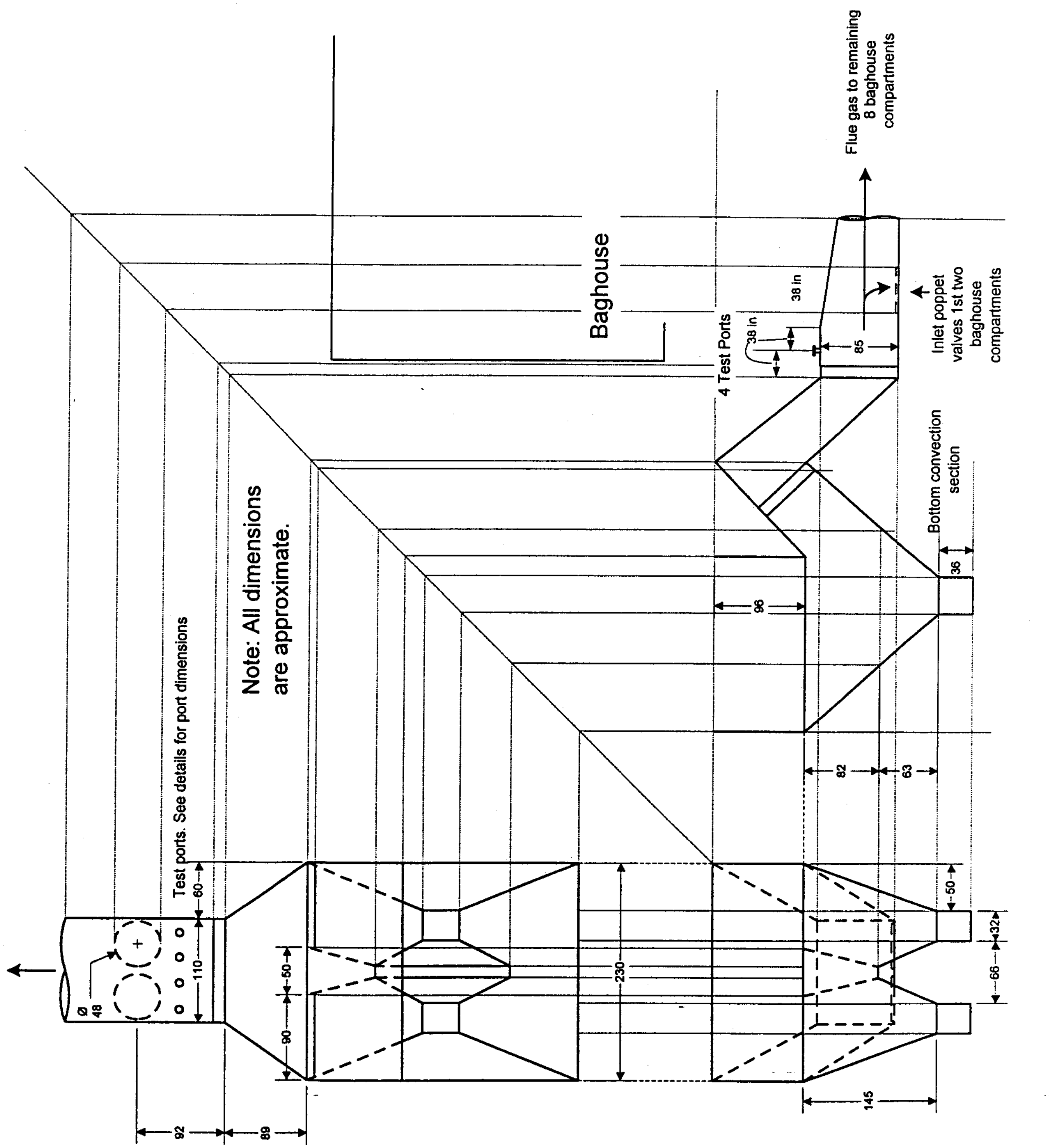

Figure 2-5 Schematic of the Inlet Sampling Location

dimension of 85 x 110 inches. Sampling was conducted for 7 minutes per point using a 4 x 6 matrix for a total of 24 traverse points. This will result in a 168-minute test run. Figure 2-6 shows the inlet port detail and traverse point locations.

Access to the inlet sampling location is by stairway and ladder to a temporary scaffold. There is a grating-type floor within the baghouse structure, 14 feet above the ports. The grating can be used for overhead support of the upper end of the sampling probe.

2.4 PROCESS FUEL SAMPLING LOCATION

The Stockton cogeneration plant fires primarily bituminous coal and fluidized petroleum coke with lesser amounts of tire derived fuel and delayed petroleum coke (these two latter fuels combined represent less than 20% of the annual heat input). If all four fuels are fired during the mercury tests, correlation of coal samples with the mercury test runs at the baghouse inlet and stack was problematic because of the mixture of fuels fired at the plant and the complexity of the fuel handling system. Referring to back to Figure 2-2, the plant silos feeding the boiler would contain a mixture of crushed coal, delayed coke, and tire chips. As a result, any fuel samples taken at the fuel feed points will contain all three fuels. Though some of the larger tire chips could conceivably be separated from the sample, segregation of delayed coke and coal is not possible because of their similar physical characteristics.

The residence time of fuel in the plant silos, assuming no fluid coke firing, is about 48 hours. There is additional uncertainty in timing of the fuel fired at any moment because the upstream storage silos may both contain a mixture of delayed coke and coal. Some of this fuel may or may not ever be fired in the boiler because of transshipment operations conducted by the plant. If all four fuels are fired simultaneously, the only unambiguous coal sampling location is at the rail cars unloading in the plant. However, it simply is not possible to link any specific coal sample with a mercury test run if sampled from the rail cars because of the extensive time lag (days). Note that fluid coke has its own feed system and does not present sampling problems during the test runs.

In the interest of providing representative fuel samples during the test runs for the mercury speciation tests, the minor fuels TDF and delayed petroleum coke were not fired over the test period. As a result, only bituminous coal was held in the plant silos. Under this circumstance, samples may be taken from a point just upstream from discharge of the plant silos to the coal feeders. The time lag from this point to firing in the boiler is less than 30 minutes allowing a reasonable correlation of the test run composite fuel sample with the test run. The fluid coke system is equipped with an automatic sampler at the discharge of the fluid coke silo so that the lag time between the sample and firing in the boiler is negligible.

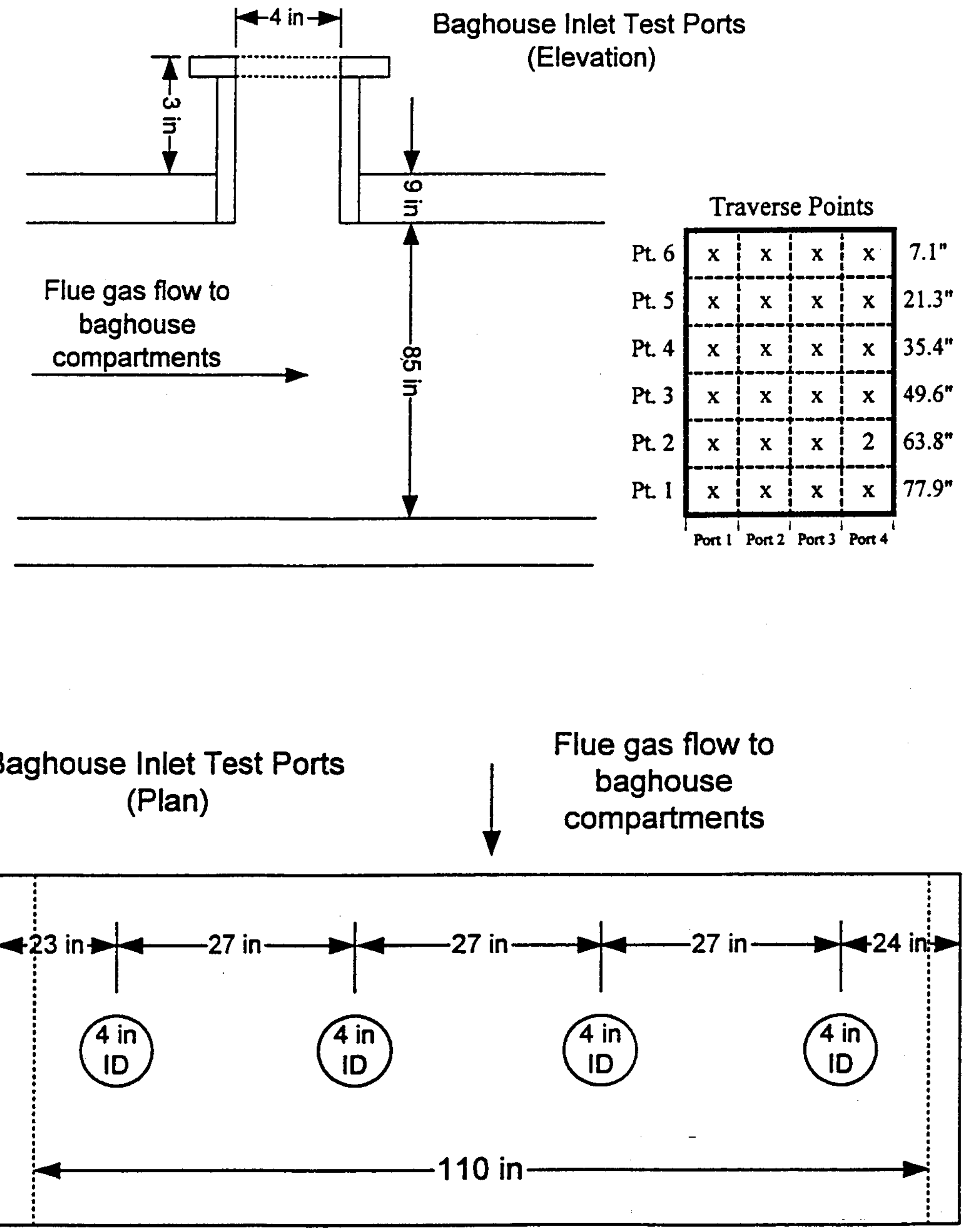

Figure 2-6 Schematic of the Inlet Port Detail

SECTION 3.0

PROGRAM DESCRIPTION

3.1 PROGRAM OBJECTIVES

The objective of the program was to determine the emissions of elemental, oxidized, particle-bound, and total mercury from both the inlet and outlet of the baghouse serving the CFBC boiler. The specific tasks associated with the objective are listed below and provided the planning, sampling, and analysis necessary to complete the test program.

Task 1: Planning

This task included the preparation of the test plan and quality assurance project plan. Both plans were used as a guide to ensure the project and results met the objectives and expectations of Stockton CoGen and the EPA.

Task 2: Preparation

This task included the preparation of the "field" laboratory and sampling equipment. As part of this task, the equipment underwent tests including pre-test calibrations, operation tests, visual inspections, and fabrication or repair as needed.

Task 3: Field Testing

This task included mobilization of the test crew, equipment set-up, performance of the field tests, and the recovery of the field samples. Fuel samples were also collected during the test program.

Task 4: Laboratory Analysis

This task included the laboratory analysis of the field samples. AVOGADRO transported the field samples to our own laboratory and shipped them for analysis to Curtis & Tompkins analytical laboratory. A.J. Edmond Co. performed the fuel analyses.

Task 5: Report

This task included the reporting and quality assurance efforts associated with the submittal of this final report of results.

3.2 TEST MATRIX

Table 3-1 presents the sampling and analytical matrix including all of the measurements that were performed at each location.

TABLE 3-1
TEST MATRIX
STOCKTON COGENERATION COMPANY
1999 MERCURY EMISSION SPECIATION TESTS

Sampling Location	Emission Parameter	Reference Method	Sample Runs	Sample Time	Analytical Method	Analytical Laboratory
Baghouse Inlet and Outlet	Mercury Speciation	Ontario-Hydro	3	160 (In) 168 (Out)	CVAAS CVAFS	Curtis & Tompkins
Baghouse Inlet and Outlet	O_2 / CO_2	EPA 3A	3	160 (In) 168 (Out)	EC cell / NDIR	Mobile lab CEMS
Baghouse Inlet and Outlet	Volumetric Flow	EPA 1, 2	3	with each mercury run	Pitot tube traverse	N/A
Baghouse Inlet and Outlet	Moisture Content	EPA 4	3	with each mercury run	Impinger weight gain	N/A
Upstream of Silos	Fuel Samples	ASTM Methods	3	grab	GCV, ash, S, Cl, Hg	A.J. Edmond Co.

3.3 TEST MODIFICATIONS AND PROBLEMS

The tests were conducted as described in the test protocol, without significant modifications to the procedures. The only modification made during sampling was in the verification of the absence of cyclonic flow.

A full traverse was made at both the inlet and outlet sites prior to beginning the first test run. The criteria for non-cyclonic flow is an average flow angle of less than 10 degrees. There was only one traverse point at the inlet site that had an angle greater than 10 degrees (Port B, point 3, 11 degrees). Rather than conduct a full traverse again for each test run, the three traverse points with the highest angles at each site were spot-checked before proceeding with each run. No angles exceeded 10 degrees during the spot checks.

There was a single modification to the calibration procedure for the pitot tubes as described in the protocol. The calibrations were done by dimensional measurement, rather than by wind tunnel measurements. This modification is a choice that is allowed by the test method.

There were no significant problems encountered during sampling or sample recovery. However, the inlet test site was a challenge for the testers. The probe had to be supported from above by rope and pulley systems attached to the rafters of the baghouse building. A large section of floor grating was removed from above the sampling ports, so that the probe could be suspended by the rope. The person manipulating the rope and pulley systems had to "tie off" for fall protection.

Moving the probe from one sampling port to the next required at least three people, especially since there were obstructions that the probe had to be lifted over in order to move from port to port. Four people were used for most of the port changes, in order to maintain the integrity of the sample and the sampling apparatus. The team managed to make port changes in 3 to 10 minutes most of the time, and virtually no damage was done to the apparatus, even to the glass nozzle used for sampling.

3.4 PRESENTATION OF RESULTS

The results of the individual test runs are presented in Tables 3-2 and 3-3. The supporting data, including the field data sheets, are provided in Appendix C. Sample calculations are shown in Appendix D, and laboratory reports in Appendix E.

This report includes copies of spreadsheet printouts (data input and results output) and example calculation checks. The field data sheets with average data calculations are also included. Any values found to be below the detection limit of the analytical method were reported as "less than" ("<") the full detection limit value. Standard conditions used for data reduction were 29.92 inches of mercury and 60 F.

The results show non-detection of any Mercury at the baghouse outlet. The detection limits were equivalent to approximately 0.1 µg/dscm for each Mercury species. The detection limits for emission rates were approximately 0.00005 to 0.00008 lb/hr.

The tests at the baghouse inlet did detect particle-bound Mercury, but no oxidized or elemental Mercury was detected. Note that the results for Run # 2-Hg-In show a non-detect for particle-bound Mercury as well. The detection limit for this sample was actually higher than the detected amounts from the other two runs.

The variation in the detection limits was due to the variation in the amount of particulate material collected on the filters. Since the laboratory digested an aliquot from the total mass of material, a larger mass calculates to a larger detection limit (from the aliquot factor). Note that while the total amount of filterable or “front-half” particulate was similar from one run to another, Run 2 had more on the filter and less in the probe wash as compared to the other runs. Therefore, the detection limit for Run 2-Hg-In was higher than for the other runs, so the amount of particle-bound Mercury was less than the detection limit for that run.

TABLE 3-2
RESULTS SUMMARY
SPECIATED MERCURY EMISSIONS
STOCKTON COGEN COMPANY
BAGHOUSE INLET

Test No.:	1-Hg-I	2 Hg-I	3-Hg-I	Average
Date:	10/20/99	10/21/99	10/22/99	--
Time:	1324-1634	1012-1306	0850-1149	--
Flue Gas:				
Flow rate, dscfm	161,455	158,145	162,071	160,557
Temperature °F	301.5	298.2	296.7	298.8
O_2, % volume dry	3.70	4.36	3.87	3.98
CO_2, % volume dry	15.82	14.99	15.76	15.52
H_2O, % volume	5.9	6.0	6.0	6.0
Particle-Bound Mercury:				
*u*g/m^3	2.74	ND<3.01	2.10	<2.62
*u*g/m^3 @ 3% O_2	2.85	ND<3.26	2.21	<2.77
lb/hr	1.7E-03	ND<1.8E-03	1.3E-03	<1.6E-03
Oxidized Mercury:				
*u*g/m^3	ND<0.137	ND<0.141	ND<0.132	ND<0.137
*u*g/m^3 @ 3% O_2	ND<0.142	ND<0.153	ND<0.139	ND<0.145
lb/hr	ND<8.3E-05	ND<8.3E-05	ND<8.0E-05	ND<8.2E-05
Elemental Mercury:				
*u*g/m^3	ND<0.134	ND<0.140	ND<0.142	ND<0.139
*u*g/m^3 @ 3% O_2	ND<0.140	ND<0.151	ND<0.149	ND<0.147
lb/hr	ND<8.1E-05	ND<8.3E-05	ND<8.6E-05	ND<8.3E-05
Total Mercury:				
*u*g/m^3	<3.01	ND<3.29	<2.38	<2.89
*u*g/m^3 @ 3% O_2	<3.13	ND<3.56	<2.50	<3.06
lb/hr	<1.8E-03	ND<1.9E-03	<1.4E-03	<1.7E-03

TABLE 3-3
RESULTS SUMMARY
SPECIATED MERCURY EMISSIONS
STOCKTON COGEN COMPANY
BAGHOUSE OUTLET

Test No.:	**1-Hg-O**	**2 Hg-O**	**3-Hg-O**	**Average**
Date:	10/20/99	10/21/99	10/22/99	--
Time:	1330-1640	1025-1325	0850-1200	--
Flue Gas:				
Flow rate, dscfm	156,965	156,837	162,253	158,685
Temperature °F	297.1	294.1	292.5	294.6
O_2, % volume dry	5.07	5.22	5.15	5.15
CO_2, % volume dry	14.54	14.51	14.50	14.52
H_2O, % volume	5.7	5.5	5.7	5.6
Particle-Bound Mercury:				
ug/m^3	ND<0.129	ND<0.146	ND<0.136	ND<0.137
ug/m^3 @ 3% O_2	ND<0.146	ND<0.167	ND<0.155	ND<0.156
lb/hr	ND<7.6E-05	ND<8.6E-05	ND<8.3E-05	ND<8.2E-05
Oxidized Mercury:				
ug/m^3	ND<0.085	ND<0.097	ND<0.089	ND<0.091
ug/m^3 @ 3% O_2	ND<0.096	ND<0.111	ND<0.102	ND<0.103
lb/hr	ND<5.0E-05	ND<5.7E-05	ND<5.4E-05	ND<5.4E-05
Elemental Mercury:				
ug/m^3	ND<0.087	ND<0.102	ND<0.101	ND<0.097
ug/m^3 @ 3% O_2	ND<0.098	ND<0.117	ND<0.115	ND<0.110
lb/hr	ND<5.1E-05	ND<6.0E-05	ND<6.1E-05	ND<5.7E-05
Total Mercury:				
ug/m^3	ND<0.301	ND<0.346	ND<0.327	ND<0.324
ug/m^3 @ 3% O_2	ND<0.340	ND<0.395	ND<0.371	ND<0.369
lb/hr	ND<1.8E-04	ND<2.0E-04	ND<2.0E-04	ND<1.9E-04

SECTION 4.0

TESTING AND ANALYTICAL PROCEDURES

4.1 TEST METHODS

A series of measurements were made to determine emissions from the Stockton Cogeneration facility. The scope included measurements of the emissions of mercury at both the CFBC baghouse inlet and outlet. Generic descriptions of the test procedures are provided in Appendix A. Descriptions of any site-specific applications or modifications to the test methods are presented in the subsections, which follow here:

4.1.1 Gaseous Emissions Measurements

The concentrations of oxygen and carbon dioxide (O_2 and CO_2) were monitored as diluent gases during the tests for molecular weight and dilution calculations. These emissions were measured using AVOGADRO's mobile Continuous Emission Monitoring System (CEMS) laboratory shown in Figure 4-1. This system meets the requirements of EPA and CARB methods for gaseous species. The sampling system operations and calibrations were performed as described in EPA Method 3A.

The calibration gas system utilizes only EPA Protocol One gases to verify the operation, linearity, and range settings of the electronic analyzers. The sample gas system allows for the introduction of the protocol gases to the analyzers either directly through the manifold (calibration error check - performed once daily) or through the sample system (system bias check - performed with each run).

4.1.2 Mercury Emissions Measurements

The emissions of mercury were measured in triplicate using the "Ontario Hydro" Mercury Method dated April 8, 1999. A copy of this method is included in Appendix A. This method applies to the determination of elemental, oxidized, particle-bound, and total mercury emissions from coal-fired stationary sources.

The mercury samples and a full field blank train (a train that is prepared, charged, assembled, leak-checked, and recovered as a sample train) was collected at each sample location according to the method. Reagent blanks were also taken and retained. The sampling train configuration was as described in Section 7 of the method using reagents and material specified in Section 8, including quartz filters. For this program, the EPA Method 5 sampling train configuration was used.

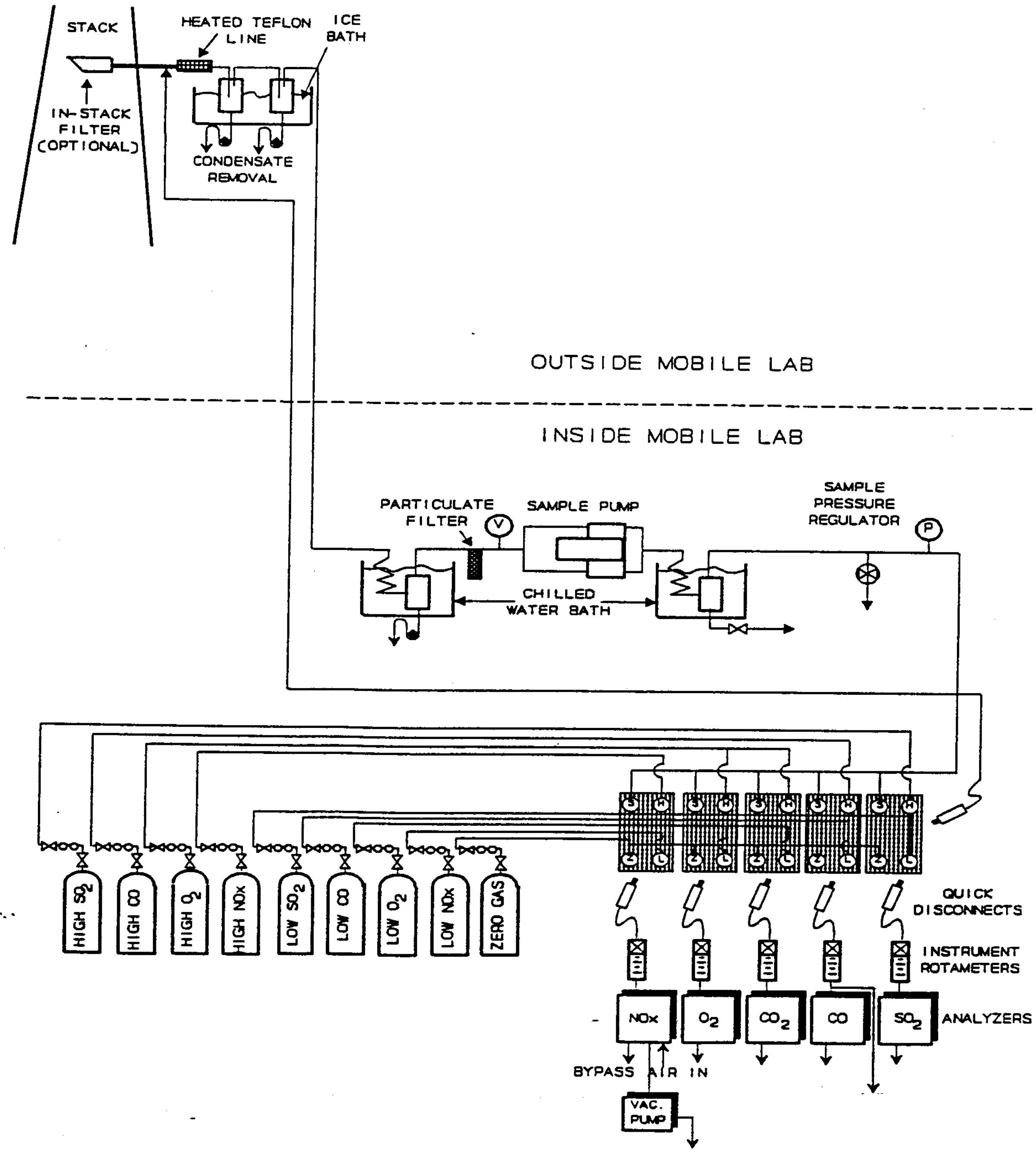

Figure 4-1 Schematic of CEM System

Pretest preparations and calibrations were completed according to the method Sections 10, 11, and 12. The sampling was conducted according to the procedure in Section 13.1. Concurrent inlet and outlet samples were each withdrawn isokinetically through a probe-filter system, maintained within 15 °C of the flue gas temperature, followed by a series of impingers in an ice bath. Particle-bound mercury was collected in the front half of the sampling train. Oxidized mercury was collected in the impingers containing potassium chloride solution. Elemental mercury was collected in the subsequent impingers (one containing an aqueous acidic solution of hydrogen peroxide and three impingers containing aqueous acidic solutions of potassium permanganate). Figure 4-2 presents a schematic of the mercury sample train.

The tests at the outlet location followed a 10-minute, 16-point matrix and were 160 minutes in duration for proper collection of between 1.5 and 2.5 dscm of flue gas. The tests at the inlet location followed a 7-minute, 24-point matrix (4 x 6 grid) and were 168 minutes in duration. The sampling times for both locations were confirmed following the calculation of pre-test flow rates and cyclonic flow profiles.

The inlet location required special attention during the test run. Because the inlet is located prior to the induced draft fan, significant negative pressure (approximately –12 iwg.) resulted at each port. To counter this problem, the sampling pump was left running to provide sufficient vacuum while the sampling probe was being removed from and inserted into the ports. Since this created the potential for dilution, the test team performed quick port changes while carefully starting and ending the tests as to minimize dilution. All potential dilution time was documented throughout the test runs.

4.1.3 Volumetric Flow Rate and Moisture Content

Volumetric flow rate measurements at both locations were made using calibrated S-type pitot tube readings from each isokinetic sampling run (i.e. the mercury runs), as described in EPA Method 2. The test team also conducted pretest measurements including cyclonic flow checks at both the inlet and outlet test locations. Moisture determinations were used from the same sampling trains. The results were used with the measured mercury concentrations for calculation of mass emission rates for each run.

4.1.4 Fuel Samples

In addition to the flue gas sampling, a single coal sample was collected during each mercury test run for laboratory analysis. ASTM D2234-97a describes the standard practice for collection of a gross sample of coal. For mechanically cleaned coal with a top size of about ¼-inch, the number of increments to be taken to form the composite

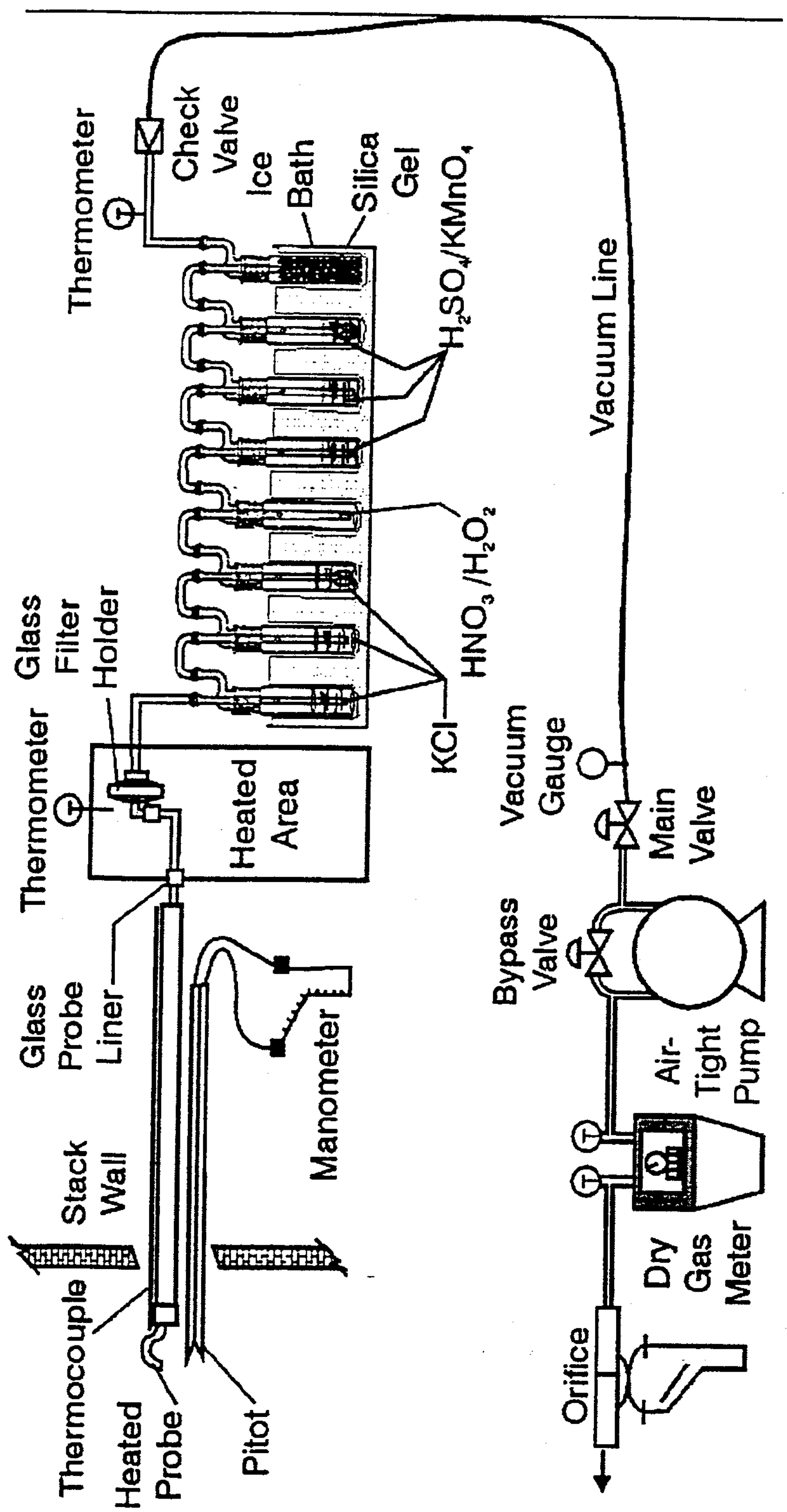

Figure 4-2 Schematic of Mercury Sample Train

sample over a test run is 15 with each increment weighing approximately 2 pounds. The sample collection condition was a partial stream cut with no operator discretion and uniform spacing in time. The number and weight of increments making up a run composite sample for fluid coke was the same.

4.2 ANALYTICAL METHODS

The mercury samples were recovered and analyzed according to the procedures outlined in the Ontario-Hydro method. After recovery, the samples were stored in an on-site mobile laboratory prior to shipment to the laboratory. Samples were recovered according to Section 13.2 of this method. Figure 4-3 presents a diagram of the mercury sample recovery procedures.

Curtis & Tompkins, Inc. of Berkeley, CA performed the digestion and analyses associated with the mercury samples. Samples were digested and analyzed for mercury using cold-vapor atomic absorption (CVAAS). These procedures were done in strict accordance with 13.3 and 13.4 of the method. Figure 4-4 presents a flow diagram of the mercury sample analysis.

A.J Edmond Co. performed the fuel analysis in accordance with ASTM Method D2234-97a for chlorine, mercury, sulfur, ash, and heating value. Analyses performed on each composite sample include the following:

- Gross calorific value (ASTM D1989)
- Ultimate analysis of coal and coke (ASTM D3176)
- Mercury (ASTM D3684)
- Chlorine (ASTM D4208)

4.3 PLANT PROCESS DATA

Unit operating conditions were determined and documented by Stockton Cogen personnel. The CFBC unit was operated at nominal, steady state full load conditions during the testing program. Documentation of the process conditions during the tests were provided by printout from the plant distributed control systems. The following process data were monitored and collected:

- Gross megawatts, MW
- Firing rates for fluid coke and bituminous coal, lb/hr
- Limestone and ammonia injection rates, lb/hr
- Main steam flow, lb/hr

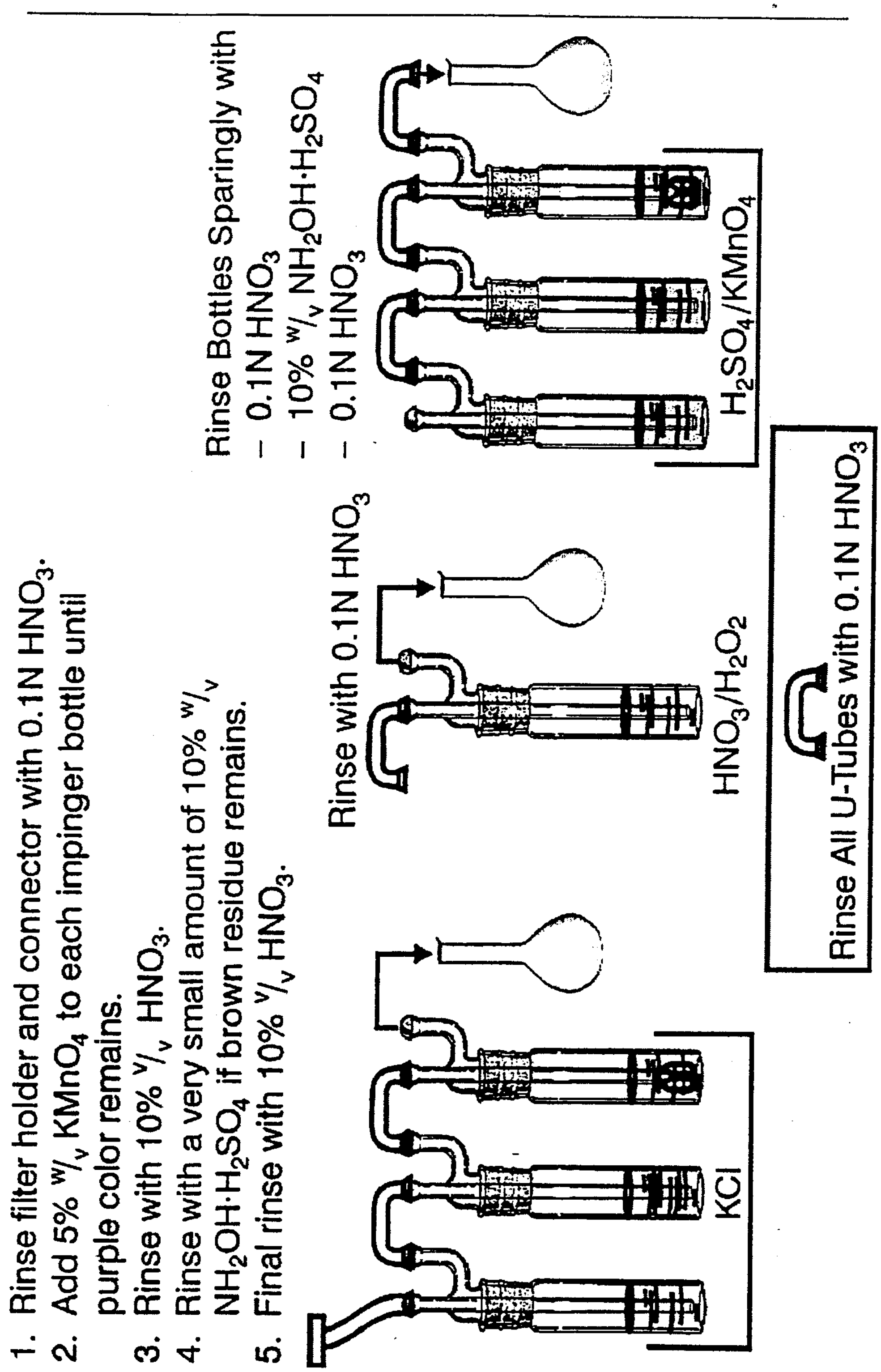

Figure 4-3 Diagram of Mercury Sample Recovery Procedures

Container 1 - *(13.3.1.2)* Sample Filter	Microwave Digestion *(13.3.2.1)*
Container 2 - *(13.3.1.2)* Nozzle Rinse Probe Rinse $F_{1/2}$ Filter Holder Rinse	Microwave Digestion *(13.3.2.1)*
Container 3 - *(13.3.3)* $B_{1/2}$ Filter Holder Rinse Connecting Teflon Line Rinse Impingers 1, 2, 3 Contents Impingers 1, 2, 3 Rinses Impingers 1, 2, 3 Crossovers	Cold Vapor Atomic Absorption Spectroscopy *(13.4)*
Container 4 - *(13.3.4)* Impinger 4 Contents Impinger 4 Rinses Impinger 4 Crossover	Cold Vapor Atomic Absorption Spectroscopy *(13.4)*
Container 5 - *(13.3.5)* Impingers 5, 6, 7 Contents Impingers 5, 6, 7 Rinses Impingers 5, 6, 7 Crossovers	Cold Vapor Atomic Absorption Spectroscopy *(13.4)*

Figure 4-4 Flow Diagram of Mercury Sample Analysis

SECTION 5.0

QUALITY ASSURANCE AND CONTROL

5.1 QA/QC STANDARD PROCEDURES

The Avogadro Group employs a rigorous on-going Quality Assurance and Quality Control (QA / QC) Program to ensure that high quality data are obtained with full documentation of test details. Our Quality Assurance Officer was Kevin Crosby. He was responsible for reviewing lab analyses, test results, and all reporting tasks. For this project, we customized our program to fit the application of the work for Stockton CoGen. A summary of our standard QA / QC program is located in Appendix B. A more specific version is located in the Site-Specific Test Protocol (SSTP) and the Quality Assurance Project Plan (QAPP).

5.2 QUALITY CONTROL REQUIREMENTS

Our Quality Assurance Program Summary located in Appendix B provides our equipment maintenance and calibration schedule, quality control acceptance limits, and any corrective action that may be needed. For additional quality control, the Avogadro Group followed the procedures outlined below as related to the Ontario-Hydro sampling and analytical methodology:

- Preliminary stack flow and temperature measurements were taken before every mercury sample run to assure correct isokinetic sampling. Cyclonic flow was also checked prior to conducting the first test series.
- The sampling train was of the EPA Method 5 configuration because of the heavy grain loading at the inlet sampling location.
- The probe liner, nozzle, and filter holder was constructed of borosilicate glass and was maintained within ±15 °C (±27 °F) of the flue gas temperature. The filter was constructed of quartz fiber.
- The sample line was constructed of heated Teflon tubing and was maintained at a minimum temperature of 120 °C.
- The acidified permanganate-filled impingers were carefully monitored throughout the test for bleaching via reduction reactions. The intent was to prevent "breakthrough" of mercury species.
- No vacuum grease was used on any glassware unions.

- All field equipment underwent a visual inspection prior to testing and included pre and post-test calibration checks.
- In addition to the normal "metals" cleaning methods, all mercury sample train glassware was cleaned in Citranox® acidic cleaning solution.
- All reagent solutions were made fresh daily. A new reagent blank was retained for every new stock of reagent.
- Only "trace metal" grade reagents were used in this test program. The Certificate of Lot Analyses for chemicals and sample containers used in this program is included in Appendix E.3.
- Chain of custody and data reduction / validation procedures were followed in strict accordance with the approved site-specific test protocol.

5.3 QA / QC MODIFICATIONS OR PROBLEMS

There were no significant QA / QC modifications or problems during the testing program. The only modification was to change from pitot tube calibration by wind tunnel measurements to calibration by dimensional measurement. This modification is a choice allowed by the test method. All other QA / QC tasks were performed in strict accordance with both the approved site-specific test protocol and quality assurance project plan.

5.4 QUALITY ASSURANCE AUDITS

Quality assurance audits were conducted as part of the mercury speciation program to ensure that the final results were calculated from the highest quality data. The individual audits are detailed below. Individual calibration results are presented in Table 5-1.

- Curtis & Tompkins, Inc. (C&T), performed duplicate and triplicate analyses according to the method and performed analysis on a spike after every ten samples. The spike, or continuing calibration verification (CCV), is directly traceable to the NIST.

- Both dry gas meters used for the inlet and outlet sampling locations were calibrated using a critical orifice (with a known calibration factor) before the commencement of the testing program. The meters were then checked immediately following the program.

- All thermocouples (TC's) and S-type pitot tubes used during the test program were calibrated before the commencement of the test program and were again checked following the test program.

TABLE 5-1
QUALITY ASSURANCE AUDITS
SPECIATED MERCURY EMISSIONS
STOCKTON COGEN COMPANY

Equipment	Pre-test audit	Post-test audit	Calculated error	Allowable error	Acceptance
Barometer	29.74	29.76	0.02	± 0.2 in.	Yes
Nozzle (0.155)	0.155	0.155	0.0	± 0.10mm	Yes
Nozzle (0.171)	0.171	0.171	0.0	± 0.10mm	Yes
Meter Box (N-2)	1.018	1.017	0.001	± 2%	Yes
Meter Box (N-3)	0.996	0.998	0.002	± 2%	Yes
Pitot (P-9D)	0.84	0.84	0.0	± 2%	Yes
Pitot (P-10B)	0.84	0.84	0.0	± 2%	Yes
TC (T-$9D_P$)	0.87	0.82	0.8	± 1.5%	Yes
TC (T-$9D_S$)	0.27	0.42	0.3	± 1.5%	Yes
TC (T-$10B_P$)	0.69	1.09	0.9	± 1.5%	Yes
TC (T-$10B_S$)	0.49	0.69	0.6	± 1.5%	Yes
TC (T-O4)	0.57	0.48	0.5	± 1.5%	Yes
TC (T-O6)	0.76	0.54	0.6	± 1.5%	Yes
TC (T-V2)	0.16	0.16	0.2	± 1.5%	Yes
TC (T-V4)	0.08	0.24	0.2	± 1.5%	Yes
O_2 Linearity	5.04	5.02	0.2	± 2%	
Bias (zero / span)	0.00 / 5.07	0.02 / 5.04	0.2 / 0.2	± 5%	Yes
Drift (zero / span)	0.00 / 5.07	0.02 / 5.04	0.2 / 0.2	± 3%	
CO_2 Linearity	14.05	14.02	0.1	± 2%	
Bias (zero / span)	0.06/14.02	0.12/14.02	0.5/0.0	± 5%	Yes
Drift (zero / span)	0.06/14.02	0.12/14.02	0.2/0.0	± 3%	